SYSTEMATIC PHOTOMICROGRAPHY AND APPARATUS PERTAINING THERETO.

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Although much has been written upon this most interesting subject, and many papers appear each month in the scientific journals, it may seem presumptuous for me, an amateur, to say that not enough stress has been laid upon the necessity for systematic work in photomicrography, in order to obtain the best results.

Too often the worker depends upon guesswork in timing exposures; is careless in arranging the light so that the field is unequally illuminated; gives little thought as to the kind of photographic plate used; develops with any developer that is handy or cheap; in fact, pays little attention to the details that are necessary to produce fine negatives.

Having once made a correct exposure, one ought to be able at any time to duplicate it, or make an approximately correct one for any similar object, under the same or similar conditions and combination of lenses and light. It is for the purpose of teaching beginners, or any who are willing to be taught, how this may be accomplished that the writer has presented this short paper.

Experience, and many failures have fully demonstrated that much valuable time would have been saved, and often great annoyance avoided, if proper data of former exposures had been preserved and at hand in convenient form for ready reference. Suppose one wished to make a photomicrograph of a histological slide stained with borax carmine, using a one-fourth objective, two-inch eye-piece and a magnification of 300 diameters, and when all had been arranged to the

satisfaction of the operator it was found that the photographic plate was thirty inches from the slide, the lamp fourteen inches, and the Abbe condenser, with pin-hole stop, one-eighth inch from slide ; how simple it would be to look over previous data and find an exposure of another slide, stained red, and same combination of lenses and light used. We would then have a sure guide as to time of exposure, and even with different lenses one would have an approximate guide.

With this object in view, some years ago, the writer had a book of forms prepared to enter and preserve such data, which is as follows :

No.....Name.....magnified.....diameters with .....objective and.....Eye-piece.....and..... inch draw tube ; using.....light at.....inches. Bull's eye condenser at.....inches and.....condenser with.....and.....stop at.....inches from slide. Exposed.....seconds, minutes on.....plates No.....at.....inches from object. Color of object ..... Date..... Remarks.....

The advantage to the worker in using such a book of data is very great, saves much time, not only in making exposures, but also in determining magnifications ; for, once determined, they are always the same for the same combination of lenses at the same distance of the plate from the object.

Fairly good photomicrographs can be made with ordinary objectives, but the best work requires the finest lenses, correct manipulation of the light, proper kind of photographic plate, right time of exposure and care in the development.

Perhaps the writer can do no better than to describe in detail the method of making a photomicrograph with the apparatus figured in Plate I.

The object to be photographed having been placed upon the stage of the microscope, and the latter turned down

horizontally to the position shown in Plate II., the operator seats himself and views the object through the microscope, centers it, arranges the light so that the field of view is equally well illuminated, focuses and, if necessary, adjusts the objective so as to obtain the best visual image possible, showing the detail he wishes to photograph.

Then, by means of the turn-table shown at L in Plate II., the microscope is swung toward and connected with the front board of the camera by pressing the front board back until the tube of the microscope is in position to pass through, when released, the opening prepared for it in the camera front.

The focusing string for fine adjustment is then passed over the milled head of the fine adjustment wheel of the microscope and placed in the groove prepared for it on the wheel, the camera back is extended until the desired amplification is obtained, and fastened by means of a set screw. Next the focus is corrected, for distance from object, by means of a focusing glass held against the screen of the camera and through which the operator looks at the image on the screen of the camera while he adjusts the focus, by means of the focusing rod, D, shown in Plate II., which extends the full length of the camera bed. The greatest care should be taken that the side of the screen on which the image is focused lies in exactly the same plane that the sensitive film of the photographic plate will occupy when placed in the plate-holder and the latter adjusted on the camera ; the plane of the focusing screen should also be at an exactly right angle to a straight line drawn from its center, through the center of the microscope tube, to the center of the source of illumination.

When the operator is satisfied that all the arrangements are as perfect as he can make them, he notes in the book of forms the full data, and determines from previous data of exposure, that has proven to be correct, the time to expose the plate. The correct exposure depends upon many circumstances : kind of light, distance of light from object, dis-

tance of photographic plate from object, sensitiveness of plate and many others.

The time of exposure having been determined, the light is shut off from the object by means of a screen placed on the sub-stage condenser-arm of the microscope, the plate-holder placed in position and slide withdrawn. The operator, with watch in hand, removes the screen and exposes the plate for the exact time, as predetermined from data-book of exposures.

With this system one can always make a second exposure, if found necessary, giving a little more or a little less time, as required, and, keeping in mind the law of light, "The intensity diminishes as the square of the distance," one can calculate just what exposure to give for different magnifications, with the same combination of lenses, provided one always works with the same light.

The next step is to develop the plate. It is very important that a good developer be used. One of the best, the writer has used, is that of Dr. William M. Gray, of the Army Medical Museum, Washington, and is made up as follows:

No. 1.—Hydrochinon ..... 96 grains.
Soda sulphite (crystal) .....480 "
Water .....8 oz.

No. 2.—Soda carbonate .....400 grains.
Water .....8 oz.

To develop take four parts of No. 1, two parts of No. 2 and sixteen parts of water. It is a slow developer, but gives great contrast and density. If developing is done in warm weather make up developer with ice-cold water and keep ice in the clearing bath. Carry the development far enough; most negatives are taken out of the developer too soon; the exact time must be learned from experience. After the plate is fully developed, wash and place it in Carbutt's acid, fixing and cleaning bath until all trace of the silver has disappeared, then in running water for one hour. For general work, the

writer has had the best success with the Carbutt orthochromatic plate, No. 23; and, when used with gaslight, no change of focus is necessary on account of visual and actinic focus.

Many are deterred from working at photomicrography on account of the prevailing idea that the necessary apparatus is very expensive. Like all other branches of study and recreation, it may be made very expensive, but really good work may be accomplished with the cheaper apparatus, if properly manipulated.

The apparatus, as shown in Plate I., excepting the microscope, can be had for less than $60, so that the claim of expense ought not to prevent such an outfit being in every institution of learning in this country, where the use of the microscope is taught. A brief description of this apparatus will not, perhaps, be amiss:

PLATE I.

Represents the entire apparatus in position for making an exposure.

a. =camera back, carrying plate holder and focusing screen.

a'.=camera front.

b. =camera front extension with circular opening for microscope tube.

c. =wood support into which curtain pulley is fastened, over which the upper loop of fine adjustment focusing string passes.

d. =focusing rod extended full length of camera bed.

e. =spool on end of focusing rod over which the lower loop of fine adjustment focusing string passes.

f. =bull's-eye condenser.

g. =Welsbach gas light.

h. =support for microscope stand, around which the lamp-carrier can be revolved so as to obtain suitable light for opaque objects.

i. =lamp-carrier with scale to show distance of light from object.

j. =stand supporting camera.

k. =sliding support for turn-table with scale to show the distance turn-table is from normal position.

l. =turn-table carrying support for microscope stand lamp and bull's-eye condenser.

m. =curtain pulleys over which focusing string from coarse adjustment wheel passes on its way to rear of camera stand.

mi.=microscope stand.

PLATE I.

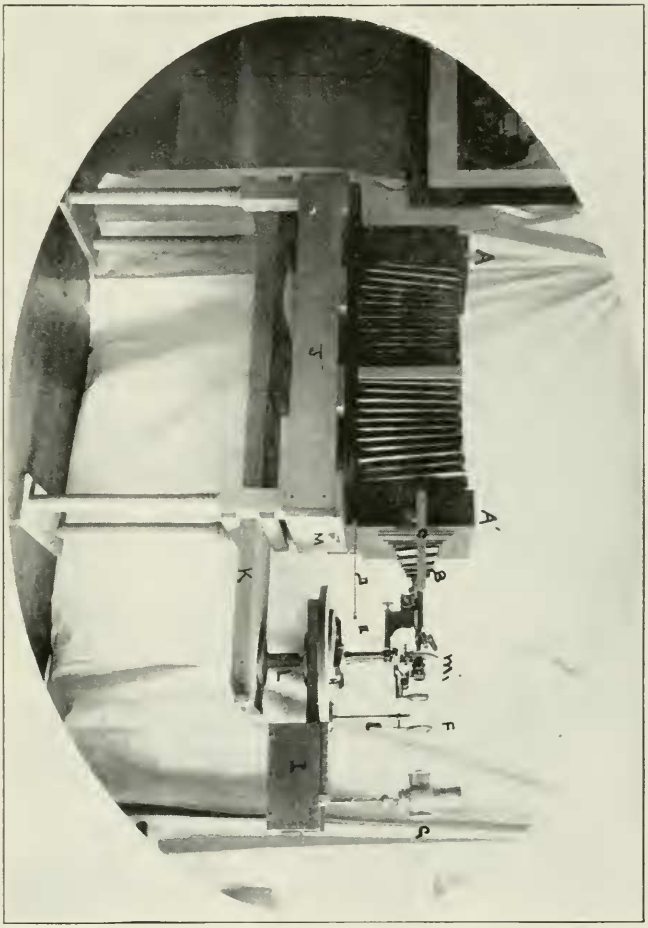

PLATE II.

Showing apparatus in position for centering and adjusting object, arranging illumination, etc.

n.=set screw to fasten turn-table in position.

o.=scale extending full length of camera bed to show distance of photographic plate from object.

p.=iris diaphragm in microscope tube, just below the eye-piece, to cut off reflection.

Other lettering same as in Plate I.

PLATE II.

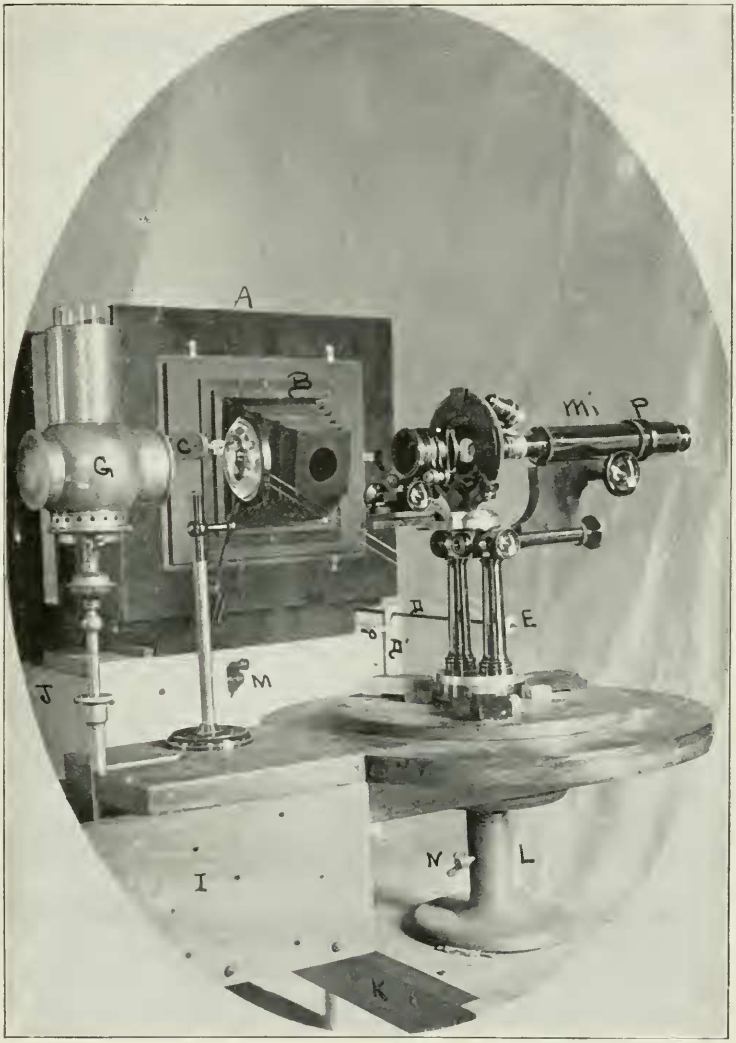

PLATE III.

Showing apparatus ready for final focusing on screen of camera.

r.=pulley over which passes upper loop of fine adjustment string.

s.=scale on arm of sub-stage condenser, to show distance of sub-stage condenser from the object.

Other lettering same as in Plate I. and II.